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called 'Wingless Birds,' Fossil and Recent, and a Few Words on Birds as a Class," in Proc. Geol. Ass., Vol. IX., February, 1886, No. 5, p. 352, pls. I.–II., London Univ. College, 1887.

L. Woolman has "Geological Results of the Boring of an Artesian Well at Atlantic City, N. J.," in Proc. Acad. Nat. Sci. Phila., Part III., p. 339.

J. L. Wortman has an article "On the Teeth of the Vertebrata" in AMER. NATURALIST, Vol. XXI., p. 463.

J. Young has "Note on a New Family of the Polyzoa—Cystodictyonidæ (E. O. Ulrich)—with Notice of Three Carboniferous Species," in Trans. Edinburgh Geol. Soc., Vol. V., Part III., p. 461.

THE DIKES OF THE HUDSON RIVER HIGHLANDS.

BY J. F. KEMP.

THE cuts of the West Shore Railway, on the Hudson river, above Haverstraw, and below Cornwall, have done much service to geology in bringing to light the subsurface and unaltered structure of the Archæan rocks. The Stony Point cut did more than any other exposure to convince Professor J. D. Dana of the intrusive character of the now famous Cortlandt series.[1] It exhibits as well one of the most interesting examples of the contortion of mica schists on the contact with intrusive rocks which any known area affords. Here also Dr. Geo. H. Williams found the types of his hornblende-peridotite,[2] and was especially aided in his careful studies of the series. Beyond Stony Point the railway crosses the belt of blue limestome so extensively quarried at Tomkins' Cove, and then in the foot of the Dunderberg meets the main mass of the Highland Archæan. Through this it has made its way by cuts, excavations and tunneling a distance of seventeen miles to Cornwall, where it again passes off the Archæan.

[1] Am. Jour. Sci., III Series, vol. xxviii., p. 384.

[2] Ibid., vol. xxxi., p. 29.

The reconnaissance survey of Dr. Britton[1] and Mr. Merrill over this line, in connection with the New Jersey survey in 1885, brought to light some, at first sight, rather obscure dike rocks which were entrusted to the writer for determination. Their interesting character, however, encouraged further investigation in the field by him the past summer, and this has led to the following results. In the October School of Mines Quarterly (Vol. IX., p. 33), Dr. Britton has outlined the results of his work. In brief he subdivides the Archæan into a basal "Massive Group," a middle "Iron-Bearing Group," and an upper "Gneissic and Schistose Group." These members, as remarked by Dr. Britton, shade more or less into one another, nor is it always easy to sharply define the individuals. In the particular section under consideration we have especially to deal with the iron-bearing and massive members as containing the dikes, for the area which is notable for their absence is regarded by Dr. Britton as belonging to the upper Gneissic and Schistose series.

Of the dikes between Tomkins' Cove and Jones' Point the writer is prevented by the unfortunate loss of a note-book from speaking with the same accuracy of location as in regard to those remaining. There are some present, though in but few instances. One slide shows a hornblende-porphyrite very similar to one found inland and about two miles west, to be described and figured in a paper forthcoming in the *American Journal of Science* for September. This is probably an outlying dike of the Cortlandt series.

From Jones' Point to Iona Island the railway skirts the Dunderberg. The rocks are gneisses, with evident laminations that strike on the average N. 40 E. Just above Jones' Point, and at intervals for two miles to the north, they are seamed with dikes. Eleven such masses were noted. They vary from six inches to twenty feet wide, and are in almost all instances very badly altered on the exposure. In fact they weather much worse than the enclosing walls, and frequently show a recess from which the specimen has to be fairly dug out. Under the microscope enough of the structure remains to show that they were in all cases either diorites or hornblende-porphyrites, consisting either of a holocrystalline aggregate of hornblende, plagioclase and magnetite, or of a ground mass now

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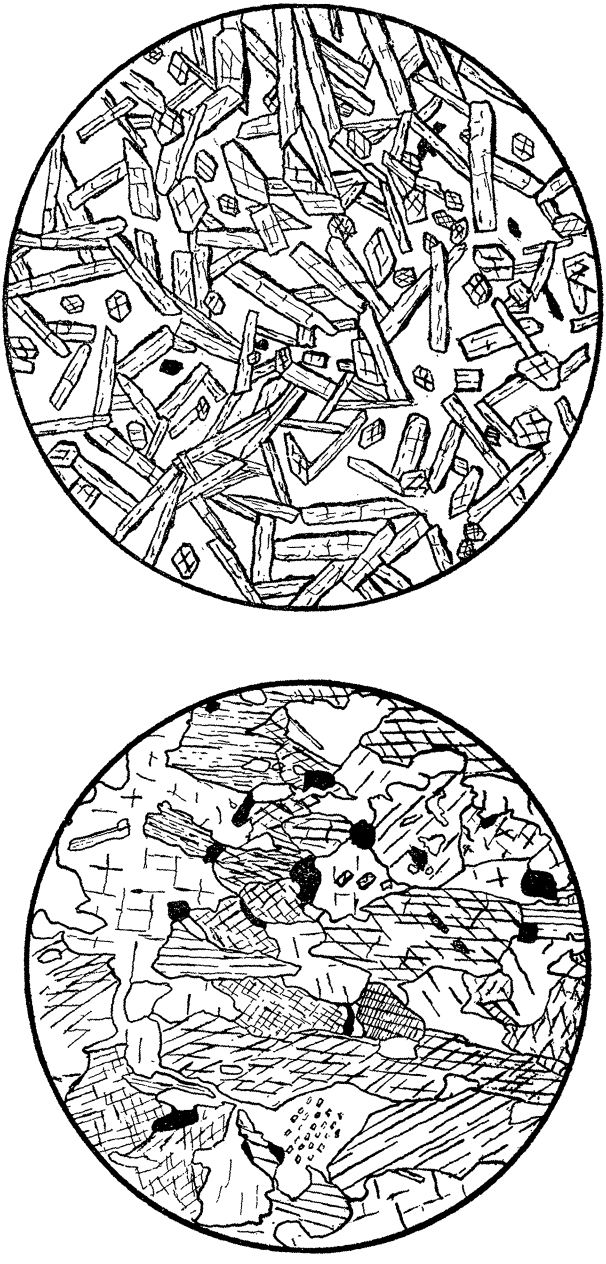
[1] See Rept. State Geol. New Jersey, 1886, p. 74.

PLATE XII.



Section of Dyke-rock from the Highlands.

merely a structureless alteration product with occasional crystals of hornblende, plagioclase and magnetite. Pyrite is sometimes seen; the same is true of biotite and small prisms of apatite. The magnetite shows indications of titanium. The Dunderberg exposures are rather conspicuously contorted and broken. The strike of the laminations of the gneiss, while generally northeast, cannot in all cases be determined. The dikes seem sometimes parallel with them, sometimes notably run across them. They may or may not have experienced some or all of the metamorphic processes through which the wall rocks have passed (an idea to be more fully developed later), but the porphyritic structure would indicate the contrary. Much in the way of contact influences, if anything, cannot be detected. They are not far from the neighboring Cortlandt series. They may have been connected with it. This at present cannot be affirmed or denied.

North of the railway station at Iona Island, a belt of hornblendic schist, with great masses of hornblende and epidote, is encountered. This association is quite typical of certain localities in the Iron Bearing group, and strongly resembles the same association of the two minerals to be seen at the Todd[1] Mine in Sprout Brook Valley, northeast from Peekskill. This last is on the line of strike from Iona Island. It is not surprising, as the writer was informed by a resident, that explorations have been made in the southwest, finding, however, nothing but lean ore, too poor to work. These outcrops possibly form a "range" similar to the well-known ranges of New Jersey, with the Croft and Stuart or Sunk mines at the extreme northeast.

Between the Poplopen creek drawbridge and Fort Montgomery, is to be seen a bed of crystalline limestone or calcite, filled with rough crystalline inclusions of an undetermined mineral, probably pyroxene, and much graphite. This is in all respects similar to those noted by Dr. Horton further to the northwest,[2] although this particular outcrop seems not to have been observed by him.

At the north end of the first cut above Fort Montgomery is a very curious narrow dike of dense black rock, four inches wide, traceable twenty feet or more vertically. It runs diagonally across the laminations of the gneiss, and seems to fill a well-defined crack.

[1] Cf. Tenth Census, vol. xv., p. 90 ff.

[2] Geol. of N. Y., 1st Dist., p. 477.

Under the microscope it is seen to consist chiefly of innumerable small but well-developed hornblende crystals, having sharply defined prismatic and pinacoidal faces. They vary from 0.02 mm. to 0.05 mm. in width, and are about five times as long. The accompanying drawing (Fig. 1), from a micro-photograph, illustrates the structure. The actual field is one millimetre in diameter. With the hornblende is some plagioclase not very well developed, as the rock has more or less of a porphyritic facies. Magnetite is sparsely scattered through it in very small grains. Slides of this rock are well nigh indistinguishable from those of the diorite described by Hawes from Campton,[1] N. H., and later by Professor Harrington from Montreal, resembling[2] less closely the similar diorite described by the writer from the Forest of Dean mine.[3] Mr. L. M. Dennis, Instructor in Chemistry in Cornell University, has made the following analysis, No. 1 in duplicate. No. 2 is of the Campton dike by Hawes, No. 3 of the Montreal dike by Professor Harrington, No. 4 of the Forest of Dean by the writer.

	I.		II.	III.	IV.
	a.	b.			
SiO_2	44.85	44.87	41.94	40.95	48.19
Al_2O_3	17.20	17.281	15.36	16.45	16.79
Fe_2O_3	11.20	11.04	3.27	13.47	18.37
FeO	....	....	9.89	....	....
MnO	trace	trace	.25	.33	....
TiO_2	6.578	6.738	4.15	3.39	....
CaO	7.52	7.54	9.47	10.53	6.85
MgO	5.02	4.946	5.01	6.10	1.32
K_2O	2.992	2.621	.19	1.28	1.11
Na_9O	1.390	1.611	5.15	4.00	5.59
P_2O_5	.383	.447	....	.29	....
CO_2	....	....	2.47	....	....
Loss on ignition	2.387	2.491	3.29	3.84	2.31
Totals	99.520	99.585	100.44	100.63	100.53

The discovery of this rock is interesting as showing the further occurrence of dikes of this character. On the basis of Hawes' description, Rosenbusch has made a separate type of dike rocks,[4] and called them Camptonites. Various outcrops of so-called trap dikes are recorded by the New York Survey in other parts of

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[1] Am. Jour. Sci. III., vol. xvii., p. 147.

[2] Geol. Survey Canada, 1877-78, p. 439.

[3] Am. Jour. III., vol. xxxv., p. 331.

[4] Rosenbusch. Mikros-Physiographie, 2d Edition, vol. i., p. 333.

Orange county, which may prove on further examination to be similar. The writer hopes, as opportunity occurs, to add to our knowledge of them.

Beyond Fort Montgomery, except in the case just cited, no dike rocks are to be seen until Cro' Nest Mountain is reached, north of West Point. The interval is made up of gneisses, very feldspathic, and considered by Dr. Britton to belong to the Upper Schistose Series. They have peculiar feldspathic masses in them which must be considered in any question of origin or metamorphic action. Great cleavage faces of feldspar as large as the hand reflect the sunlight from the sides of the cuts. Cro' Nest and Storm King form the northern boundary of the Highlands west of the Hudson. They consist of rocks which are described by Dr. Britton[1] as quartz-syenite, and are considered as typical of the massive group. The laminations are generally apparent, but in many instances the rocks present a well-nigh massive appearance. Running like broad black ribbons in directions generally vertical, across the exposed faces are numerous dikes varying in width from a few inches to forty feet. Fifteen were noted in Storm King, six in Cro' Nest.

These dikes are very uniformly holocrystalline aggregates of hornblende, augite and plagioclose as principal minerals, with subordinate magnetite and apatite, and occasionally a little biotite, orthoclase and quartz. The hornblende and augite are generally associated, but there are instances in which each appears alone with the other minerals mentioned. The augite appears alone especially in those dikes whose wall rock is most broken and contorted. The hornblende is of the common brown variety strongly pleochroic. It is never in well-bounded crystals, but always in irregular masses, whose external shapes are conditioned by their neighbors. It frequently contains included the apatite and magnetite, and the masses vary from 0.5 mm. to 1.0 mm. in width, but are relatively somewhat longer. In the more altered specimens the hornblende tends to bleach out to a green variety. The augite is in the same irregular masses of light green color, and contains the same inclusions, but on the whole is less prone to do so. The biotite is far less abundant than the two just mentioned, contains, however, magnetite inclusions, but in other respects shows no peculiarities worthy of note. The feldspar is in irregular masses, well twined, and contains not unfrequently as inclusions the hornblende and augite, as well as magnetite and apatite. By powdering the rock and carefully separating the feldspar by means of the Thoulet's heavy solution the specific gravity was found to lie between 2.67 and 2.70, bringing it near Labradorite.[11] The magnetite is in coarse, irregular masses, showing no indications of titanium. The apatite prisms are also quite coarse. It follows, therefore, from the relations above set forth, that, according to the well-known general law,[12] the magnetite and apatite have been first to form, and have then been taken up in the mass of the hornblende, augite and biotite in their subsequent crystallization, while the feldspar has been last of all to form, as it includes all the others. In the accompanying figure (Fig. 2), taken from a microphotograph, the structure of a typical specimen is shown. The actual field is 4.0 mm. in diameter. The different minerals, hornblende, augite and plagioclase are well indicated by their characteristic cleavages.

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[1] The School of Mines Quarterly, vol. ix., p. 34.

In the matter of classification these rocks are perhaps most nearly allied to those called by Rosenbusch Camptonites,[13] but in the matter of structure it should be stated they differ widely from the typical Camptonites in the writer's possession, for anything like a porphyritic structure is entirely lacking. Although differing from the typical and widely-known kersantites in the small amount of biotite contained, they yet, with some described varieties,[14] seem structurally related. A normal kersantite has been described from this region by Dr. Newberry,[15] which seems to form a boss in the enclosing gneiss at Croton Point.

[1] Rosenbusch. Mikros-Phys. 2d Ed., vol. i., p. 535.

[2] Rosenbusch. Neues Jahrbuch f. Min., etc., 1882, II., p. 1-16.

[3] For a translation of Rosenbusch's scheme, see the Amer. Naturalist for March and April, 1888, p. 207, etc. It is much to be regretted that Professor Bayley did not translate in this connection the German word "gang" by our English equivalent "dike." The English word "vein" is now so well understood in all the literature on ore deposits to refer to a mineral body deposited from solution, that an intrusive or igneous vein seems a misnomer.

[4] Cf. Pohlmanns. 4th Group. Neues Jahrb. Beil. Band., III., 1884, p. 67.

[5] The School of Mines Quarterly, vol. viii., p. 330, July, 1887.

In some cases these dikes are parallel to the laminations of the enclosing gneiss or syenite, in other cases cut across them. Many would seem at first sight to be interbedded masses, and the writer would confess himself inclined at first to take the view that if these mountains are to be considered metamorphosed sediments, then these dikes represent strata of composition different from the remainder. There are, however, illustrations, as stated above, of unconformability, and not only that, but of two separated and unconformable branches joining above while separated below. (Spec. 32 and 33, two dikes each twelve feet wide just south of Cro' Nest flag station.) They are, therefore, esteemed of undoubted intrusive origin.

The dikes are not infrequently faulted by feldspathic segregations. In Storm King, above the paving stone quarry, six, from four inches to eighteen inches wide, are exposed, four of which are faulted by such a segregation. The inference from this is that the dikes are of great geological antiquity. These feldspathic masses consist chiefly of very coarsely crystalline orthoclase. Such a mass we know would form only under high pressure and great heat,[1] and indicates the changes through which these rocks have passed since the dikes were intruded. The geological date of the metamorphism, if such it were, which gave these syenites or gneisses their present form, it is not easy to state, but from the comparatively unchanged condition of the strata lying against them to the north at Cornwall, it must have been before the Hudson River Period of the Lower Silurian. In the writer's opinion the dikes were intruded in Archæan time, and have experienced the same influences which have given the gneisses their bedded character. It cannot be affirmed that the dikes themselves are metamorphosed from their original structure, but it is interesting to note that they exhibit even in their narrowest examples a perfect holocrystalline structure, nor is any amorphous or porphyritic matter to be detected. We infer from this either that they were intruded between highly heated walls, and that they cooled slowly and under pressure like a plutonic rock (Tiefengestein); or else that subsequent metamorphism has recrystallized any first formed porphyritic matter. The metamorphism of igneous or intrusive rocks is a subject now attracting much attention, and has important bearing on the origin of the Archæan.[1] As for explaining the slight bedding or laminations of the wall rocks by previous sedimentary stratification, while it is not easy to adduce any positive facts against it, the writer does not believe in it. It seems most reasonable to regard the laminations as due to pressure exerted normally to them, and that the pressure was in almost all cases normal to the dikes as well.

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[1] Hautefeuille, Comptes Rendus, 1877, t. lxxxv., p. 952, idem. t. xc., 1880, p. 830. Friedel et Sarasin, B. Soc. Min., 1879, p. 158, and 1881, p. 171.

The origin of these well-nigh massive basal rocks of the Archæan is certainly at present a most uncertain theme. Yet, although it is readily to be seen from much that has been written how easy it is to indulge in laboratory speculations which afford little else than controversial material, the writer would nevertheless advance the conclusions drawn from the structure and composition of these dikes as legitimate if not incontrovertible inferences.

SCIENCE IN UTOPIA.

BY C. L. HERRICK.

IT has doubtless been a matter of regret to many of my readers that since the publication of the valuable memoirs of Sir Thomas Moore upon Utopia no one has succeeded in penetrating the veil of mystery hanging over those happy islands.

For my own part I have often amused myself by wondering whether egress is as difficult as access and in imagining a sort of espionage of modern institutions by that conservative and self-satisfied community.

Very unexpectedly my vagaries were suddenly proven realities and I am permitted to record the results of an extended conversation with a representative and very intelligent member of the recent scientific congress of Utopia.

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[1] This has been strongly advocated by Lehmann. Entstehung der Altkrystallinen Schiefergesteine. Reviewed by D. Geo. H. Williams in Am. Jour. Sci. III., vol. xxviii., p. 392.